ENGLISH TRANSLATION OF PCT/EP2004/008154 SPECIFICATION, CLAIMS, ABSTRACT, 1 SHEET OF 2 FIGURES AND COVER PAGE (17 pages)

FULL JACKET HELICAL CONVEYOR CENTRIFUGE WITH DIRECT DRIVE

[0001] The invention relates to a full-jacket helical conveyor centrifuge according to the preamble of Claim 1.

[0002] It is known to drive centrifuges in many different manners. In the field of full-jacket helical conveyor centrifuges, it has caught on to equip the helical conveyor and the drum respectively with a driving device in order to be able to control these two elements separately from one another without any tie to a fixed transmission ratio. Such a state of the art is known from German Patent Document DE-A-2811887 or DE 1732887.

[0003] For driving the drum, a belt drive is generally used which has been successful in practice but which requires a relatively large amount of space and therefore, because of frictional heat in the event of a belt slip, generates high temperature at the belts and the pulleys and is also often relatively loud. A demand therefore exists for alternative drive concepts where a belt drive is avoided.

[0004] For example, in the case of laboratory centrifuges, electromagnetic drives are also known; such as magnets in a rotating beaker glass. Furthermore, from European Patent Document EP 0 930 099 B1, an electromagnetic transmission for driving a laboratory centrifuge is known which is connected behind an electric motor but which is not suitable for larger centrifuges, such as full-jacket helical conveyer centrifuges. A spinning centrifuge in the manner of a magnetic drive is also illustrated in German Patent Document DE 74 26 623 U1.

[0005] The use of an axial-field electric motor in the case of a sugar drum-type centrifuge without a helical conveyor is also known from German Patent Document DE 33 25 566 C2. In contrast, a use on a full-jacket helical conveyor centrifuge has so far not been considered, probably because this type of centrifuge always also requires a drive for the helical conveyor and because an excessive heating of the product by way of the drum was also feared. An analogous situation applies to the solutions of German Patent Document

DE 40 08 945 C2, which shows an evaporator - concentrator centrifuge, and German Patent Document DE 38 34 222 C2.

[0006] It is an object of the invention to create a full-jacket helical conveyor centrifuge having a drive as an alternative to a belt drive.

[0007] The invention solves this task by means of the object of Claim 1.

[0008] Accordingly, the drive device for the horizontally disposed drum has at least one electromechanical direct drive(s), whose primary or secondary elements in a particularly preferred manner are arranged directly at or on the drum or - in a less preferred manner - at or on a part non-rotatably connected with the drum, and whose corresponding secondary or primary elements are arranged at a distance outside the drum or the part non-rotatably connected with the latter with no contact between these, the propulsion force being generated without gears by an electromagnetic field of travelling waves which advances outside the drum around the metallic drum or around the part non-rotatably connected with the latter. This can be implemented, for example, by a large number of successively controllable coils on the outer periphery of the drum which are used as the primary elements for generating the field of travelling waves in order to, in the process, take along a large number of the particularly permanent-magnetic secondary elements.

[0009] Thus, the impressively simple concept of a field of travelling waves which is generated directly without an electric motor on the input side and which advances, for example, on the outer periphery of the drum around the drum and does not penetrate the latter like a rotating field, is utilized in a simple manner also for the direct drive of a centrifugal drum of a decanter with a helical conveyor. As recognized by the invention, the helical conveyor can definitely also be driven in manner different from that of the drum, thus, for example, by means of a conventional rotating-field electric motor. The problem of the heat development of a product by way of the drum can also, against all expectations, be controlled in the case of a full-jacket helical conveyor centrifuge. In

addition, a continuous rotational speed adjustment can take place in a simple manner also without a frequency converter.

[00010] In this case, the ratio between the inner axial dimension of the drum and its inside diameter is preferably greater than 1, particularly greater than 2.5. Specifically in the case of such drums, the "field of travelling waves drive" can be accommodated in a simple manner in the area of the elongated drum without interfering with function elements at the axial ends of the drum.

[00011] By means of the invention, a belt drive for the drum can be eliminated in the most simple manner. Instead, an electromagnetic gearless direct drive is surprisingly used for the drum, which direct drive has a compact construction while the torque is high and is easily controllable in a low-noise manner. As a result, a safety advantage is also obtained because the drum can be braked particularly rapidly by means of the direct drive.

[00012] Particularly preferably, the secondary elements of the at least one direct drive are arranged on the outer periphery of the drum or on the outer periphery of a part non-rotatably connected with the drum, and the primary elements are in each case arranged radially outside the secondary elements at a distance from these with no mutual contact. By means of this arrangement, a particularly compact variant of the invention is easily implemented and permits the complete elimination of a gear. Disadvantageous axial forces upon the bearing are avoided.

[00013] The invention is suitable for a use in the case of full-jacket helical conveyor centrifuges. There are many points of the drum of this type of a centrifuge on which - depending on the performance and constructively geometrical situation - one or more electromagnetic direct-drive devices for the drum can be arranged. The compact arrangement is particularly advantageous here because the drive device can be integrated completely into the decanter frame or the machine frame. Further advantages are the low generating of noise and, under certain circumstances, even vibration-damping

characteristics. The forces acting upon the drum bearing which would be applied by a belt drive are eliminated.

[00014] Theoretically, several of the electromagnetic direct drives may also be arranged on the drum or the part non-rotatably connected with the drum.

[00015] The drum itself, particularly its cylindrical section, in contrast, from a constructive point of view, offers the particularly preferred site of the arrangement of the direct drive. Although a thermal influence affects the drum and the centrifugal material in this area, it generally can be kept low.

[00016] If, on the other hand, an attachment is used as an axial extension of the drum for arranging the direct drive, an additional heat development of the product area by way of the drum is avoided. Nevertheless, a drive directly on the drum between the two main bearings is preferred, particularly because here also negative loads of the drive upon the main bearings can be largely avoided.

[00017] Particularly preferably, the primary or secondary elements surround the drum completely or in sections concentrically. The arrangement in sections thereby clearly simplifies the constructive expenditures.

[00018] In this case, it is also conceivable that the primary or secondary elements are arranged on a ring disk projecting radially from the drum or a part non-rotatably connected with this drum, which ring disk is non-rotatably connected with this drum/part, and that the corresponding secondary or primary elements are arranged on a non-rotatable ring disk or on a ring, which is arranged, for example, in an axially offset manner parallel to the co-rotating disk.

[00019] The field of usage of the invention is the full-jacket helical conveyor centrifuge; thus, the so-called decanter having a helical conveyor, where a belt drive for the drum can be replaced. The helical conveyor can arbitrarily be driven in a different manner; for example, hydraulically or mechanically or by way of a gearing between the drum and the helical conveyor or by way of another direct drive with a field of travelling waves

arrangement. In this case, a gearing between the drum and the helical conveyor can also be eliminated.

[00020] The invention therefore also creates a full-jacket helical conveyor centrifuge with a rotatably disposed metallic drum and a rotatable helical conveyor as well as a drive device for the drum and a drive device for the helical conveyor, at least the drive device for the helical conveyor having at least one electromechanical direct drive(s) whose primary or secondary elements are arranged directly at or on a part non-rotatably connected with the helical conveyor, and whose corresponding secondary or primary elements are arranged without contact at a distance outside this part, the propulsion force being generated without gears by an electromagnetic field of travelling waves which advances around the part non-rotatably connected with the helical conveyor. In this manner, a gearing between the drum and the helical conveyor could even be eliminated, so that the two elements can be controlled completely independently of one another. In this case, it is advantageous to further develop both drives, that is, the drive for the drum and that for the helical conveyor, as a direct drive.

[00021] It is conceivable that the drum and/or the helical conveyor have at least one play-free bearing around which or directly adjacent to which the respective electromagnetic direct drive is arranged.

[00022] Preferably - but not necessarily -, the drive device for the helical conveyor is constructed independently of the drive device for the drum.

[00023] It is finally advantageous for another co-rotating field of travelling waves motor to generate (only) the required differential rotational speed between the helical conveyor and the drum, so that it has only small dimensions and is therefore cost-effective.

[00024] Advantageous further developments are contained in the subclaims.

[00025] In the following, the invention will be described in detail by means of an embodiment with reference to the figures.

[00026] Figure 1 is a sectional view of a full-jacket helical conveyor centrifuge with a schematic representation of the drive device for the drum, which is shown in several alternative arrangements; and

[00027] Figure 2 are two schematic views of centrifugal drums with direct drives for illustrating the method of operation of the invention.

[00028] Figure 1 illustrates a full-jacket helical conveyor centrifuge 1 with a rotatably disposed drum 2 and a rotatably disposed helical conveyor 3, which has a differential rotational speed with respect to the drum 2 in the operation.

[00029] The drum 2 as well as the helical conveyor 3 each have a cylindrical section 2a, 3a with at least one outlet 5 for a liquid phase as well as a tapering, for example, conical section 2b, 3b adjoining on one side and having an outlet 28 for a solids phase.

[00030] On its cylindrical end, the drum 2 is closed off by a drum lid 4 which has the outlet 5 for the liquid phase, behind which, purely as an example, a chamber 6 is connected which has a centripetal pump 7 stationary in the operation and, in turn, followed by a discharge 8, but which (outlet ? translator) can also be followed by a baffle plate or directly by a discharge (not shown here).

[00031] An inflow pipe 9 leads axially through the helical conveyor 3 or the helical conveyor body from the cylindrical end of the drum 2 into a distributor 10 which has openings 11 into the centrifugal space 12 between the drum 2 and the helical conveyor 3.

[00032] Between the drum 2 and the helical conveyor 3, bearings 13, 14 are arranged on both sides of the drum 2. In addition, the drum 2 is disposed at its two axial ends by means of drum bearings 15, 16 on a machine frame 17 not shown here.

[00033] The drum 2 has several parts which are non-rotatably connected with it. These include the chamber 6 for the centripetal pump as well as in each case several cylindrical attachments 17, 18, 19, 20 of the drum 2 which, for example, may be arranged in the axial direction between the main drum bearings 15, 16 or laterally outside the main drum bearings 15, 16 on both axial ends of the drum 2. The ratio between the axial inner

dimension of the drum and the maximal inside diameter is greater than 1, particularly greater than 2.5; particularly greater than or equal to 3. As an axial extension of its conical section 3b, the helical conveyor 3 has a shaft 21 which is adjoined by the first drive device 22 - for driving the helical conveyor 3 -, which drive device 22 in this case comprises a gearing 23 and an electric motor 24.

[00034] At least one gearless electromagnetic drive 25a-f is used as the second drive device or as the drive device for the drum 2. The electromagnetic direct drive 25a-f can preferably be arranged at different points of the drum 2 or on a part preferably non-rotatably connected with the drum 2, which here is illustrated as an example by the total of six drive devices. It is also conceivable to provide several drive devices at the drum 2 or on the parts non-rotatably connected with the drum 2.

[00035] Rotor or secondary elements 26 are in each case arranged on the cylindrical section 2a of the drum 2 or on a cylindrical part (for example, the parts with the reference numbers 6, 17, 18, 19, 20) non-rotatably connected with the elongated drum 2, as well as primary elements 27 are arranged concentrically with respect to the secondary elements 26 and at a distance to the latter without contact. Here, the ends of the drum, at which the discharges for the solids and liquid phases are situated, remain free of elements of the drives.

[00036] The primary elements 27 may extend around the entire periphery of the drum 2 or only over a sector of a circle, for example, over a periphery of 90°.

[00037] The electromagnetic direct drive is constructed similarly to an electromagnetic "linear motor"; except that the latter here, either completely or in sections - which constructively is particularly simple -, is guided around the drum 2 or the part non-rotatably connected with the drum. In this case, a plurality of - for example, more than eight - primary elements 27 - such as respective coils - are used to construct a magnetic field of travelling waves which virtually travels on the outside around the metallic full-jacket drum and, in the process, takes along a plurality of - for example, more than eight - in particular, permanent-magnetic or coil-type secondary elements 26 on the drum. This is

purely schematically illustrated in Figure 2. The primary elements 27 surround the drum preferably in sections or completely, and the secondary elements 26 surround the drum completely.

[00038] The secondary elements 26 are preferably arranged on a cylindrical section of the drum 2, particularly in the area of the axial center (for example, at 25d) of the drum 2, or completely or in sectors around the latter and preferably placed radially on the latter.

[00039] The cylindrical section is the preferred site of the drive. Here, the axial ends of the drum remain free of drive components, components for the drum, which simplifies the construction of the arrangement.

[00040] As an alternative, an axial attachment 6, 18, 19, 20, 17 on the drum, which is non-rotatably connected with the drum, can be utilized for arranging the secondary elements 26. This attachment 6, 18, 19, 20, 17 can be arranged in the axial direction preferably inside or outside the drum bearings 15, 16 as well as as an axial extension of the drum 2 or on the conical section 2b of the drum - attachment 17 -. Attachment 19 could contain a gearing between the helical conveyor and the drum. This embodiment is less preferable.

[00041] As an option/alternative, the helical conveyor 3, can also be driven, for example, at the shaft 21 or at an element (not shown here) non-rotatably connected with the latter, by means of a separate additional direct drive (also not shown here) in the manner of a direct drive for the drum 2. In this case, even a gearing between the drum 2 and the helical conveyor 3 could be eliminated.

[00042] By means of a control unit, which is not shown here and has no frequency converter, the rotational speed of the drive and thus of the drum 2 and/or the helical conveyor 3 can be arbitrarily adjusted.

Reference Symbols

Full-jacket helical conveyor centrifuge	1
drum	2
helical conveyor	3
cylindrical sections	2a, 3a
conical sections	2b, 3b
drum lid	4
outlet	5
chamber	6
centripetal pump	7
discharge	8
inflow pipe	9
distributor	10
openings	11
centrifugal space	12
bearing	13, 14
drum bearings	15, 16
attachments	17, 18, 19, 20
shaft	21
first drive device	22
gearing	23
electric motor	24
second drive device	25a to 25f
secondary elements	26
primary elements	27
solids outlet	28